VOLTAGE APPLIED FOR VARIOUS COMBINATIONS OF ELECTRICAL CONNECTIONS—Continued

Voltage sources connected between	Value*
(a) and (h) note (6)	1000
(b) and (c)	1500
(b) and (d)	1500
(b) and (e)	1500
(b) and (h)	1500
(c) and (f)	1000
(c) and (g)	1000
(d) and (f)	1000
(d) and (g)	1000
(f) and (h)	1000

*Value to which test voltage is gradually increased, rms, 60 Hertz.

NOTES: (1) If, in any operational state, one of the telephone connections, auxiliary leads or E&M leads has an intentional conducting path to earth ground, that lead may be excluded from the leakage current test in that operational state. Connections excluded for this reason must comply with the requirements of §68.306(c) in addition to the other applicable rules. However, leakage current tests between telephone connections and auxiliary leads, and between telephone connections and E&M leads are required unless both points have intentional conducting paths to earth ground.

(2) Terminal port connections to registered protective circuitry shall be treated as point (d) leads for the purposes of leakage current limitation.

(3) Leakage current limitations shall be met between each of the point (d) and point (f) leads and all pairs of tip and ring telephone connections. (Testing all pairs may be done by a sequence of appropriate combinations of pairs.)

(4) Equipment states which cannot be achieved by normal means of power shall be achieved artifically by appropriate means, if necessary to comply with the requirements of this section.

(5) For multi-unit equipment interconnected by cables, which is evaluated and registered as an interconnected combination or assembly, the specified 10 milliamperes peak maximum leakage current limitation, other than between power connection points and other points, may be increased as described here to accommodate cable capacitance. The leakage current limitation may be increased to (10N+0.13L) milliamperes peak where L is the length of interconnecting cable in the leakage path in meters and N is the number of equipment units which the combination or assembly will place in parallel across a telephone connection. However, all combinations of electrical connections requiring the increased limitation and involving point (c) (exposed conductive surfaces) surfaces must comply with the requirements of §68.306(c) in addition to other applicable rules.

(6) Leakage current limitations shall be met between each of the point (h) leads and all pairs of tip and ring telephone connections.

[45 FR 20853, Mar. 31, 1980, as amended at 51 FR 944, Jan. 9, 1986; 58 FR 44907, Aug. 25, 1993]

§68.306 Hazardous voltage limitations.

(a) *General.* Under no condition of failure of registered terminal equipment or registered protective circuitry, or of equipment connected thereto, which can be conceived to occur in the handling, operation or repair of such equipment or circuitry, shall the open circuit voltage on telephone connections exceed 70 volts peak for more than one second, except for voltages for network control signaling and supervision, which, in any case, should be consistent with standards employed by the telephone companies.

(1) Registered terminal equipment shall assure that at the MR channel interface, no continuous ac or dc voltages appear across the tip (MR) and ring (MR) leads, from the tip (MR) lead to PBX ground, or from the ring (MR) lead to PBX ground.

(2) Registered terminal equipment shall assure that during normal operation, at an AIOD data channel interface, (i) no significant ac voltage to ground other than for data transmission appears on the tip (AI) and ring (AI) leads; (ii) no open circuit dc voltage to ground appears on the tip (AI) and ring (AI) leads other than in the range from 0 to −56.5 volts.

(3) Registered terminal equipment shall also assure that at either the MR channel interface or an AIOD data channel interface, voltage transients appearing on either the tip (AI or MR) or ring (AI or MR) to ground as a result of inductive components in the registered terminal equipment shall not be capable of delivering more than 2 joules to a 500 ohm resistive termination.

(4) *Type I E&M leads.* Conditions for ''A'' side of interface with conditions for ''B'' side in parentheses. Registered terminal equipment shall assure that the dc current in the E lead does not

*The ac component should not exceed 5 volts peak or the dc component 5 volts, where not otherwise controlled by §68.308.

exceed 100 milliamperes, no significant ac voltage to ground appears on the E&M leads,* no significant ac or dc voltage to ground appear on the (E) & (M) leads,* and the open circuit dc voltage to ground on the E&M leads does not exceed 56.5 volts and is not positive. M lead protection shall be provided to assure that voltages to ground do not exceed 80 volts. For relay contact implementation a power dissipation capability of 0.5 watt shall be provided in the shunt path. If the registered terminal equipment contains an inductive component in the E lead, it must assure that the transient voltage across the contact as a result of a relay contact opening, does not exceed the following voltage and duration limitations:

(i) 300 volts peak,

(ii) A rate of change of one volt per microsecond, and

(iii) An 80 volt level for more than 10 milliseconds.

(5) *Type II E&M leads.* Conditions for ''A'' side of interface with conditions for ''B'' side in parentheses. Registered terminal equipment shall assure that the dc current in the E and (SB) leads does not exceed 100 milliamperes and no significant ac voltage to ground appears on the E and (SB) leads,* no significant ac or dc voltages to ground appear on the M, SG, SB (E), (SG), and (M) leads from sources in the registered terminal equipment,* and the open circuit dc voltage to ground on the E and (SB) leads does not exceed 56.5 volts and is not positive. If the registered terminal equipment contains an inductive component in the E or (M) lead, it must assure that the transient voltage across the contact, as a result of a relay contact opening, does not exceed the following voltage and duration limitations;

(i) 300 volts peak,

(ii) A rate of change of one volt per microsecond, and

(iii) An 80 volt level for more than 10 milliseconds.

(6) *Off-premises station voltages.* (i) Talking battery or voltages applied by the PBX (or similar systems) to OPS interface leads for supervisory purposes must be negative with respect to ground, shall not exceed 56.5V dc for Classes A, B, and C, and shall not have a significant ac component.*

(ii) Ringing signals applied by the PBX (or similar systems) to OPS interface leads shall be applied for the purpose of station alerting only, and shall comply with requirements in paragraph (d) of this section. Ringing voltages shall be applied between the ring conductor and ground.

(7) For Local Area Data Channel interfaces, during normal operating modes including terminal equipment initiated maintenance signals, registered terminal equipment shall assure, except during the application of ringing (limitations specified in paragraph (d) of this section), with respect to telephone connections (tip, ring, tip 1, ring 1) that:

(i) Under normal operating conditions, the rms current per conductor between short-circuited conductors, including dc and ac components, does not exceed 350 milliamperes. For other than normal operating conditions, the rms current between any conductor and ground or between short-circuited conductors, including dc and ac components, may exceed 350 milliamperes for no more than 1.5 minutes.

(ii) The dc voltage between any conductor and ground does not exceed 80 volts. Under normal operating conditions it shall not be positive with respect to ground (though positive voltages up to 80 volts may be allowed during brief maintenance states);

(iii) Ac voltages are less than 42.4 volts peak between any conductor and ground, (Terminal equipment shall comply while other interface leads are both (A) unterminated and (B) individually terminated to ground); and,

(iv) Combined ac and dc voltages between any conductor and ground are less than 42.4 volts peak when the absolute value of the dc component is less than 21.2 volts, and less than (28.8 + 64 × Vdc) when the absolute value of the dc component is between 21.2 and 80 volts.

(8) During normal operation, registered terminal equipment for connection to ringdown voiceband private line interfaces or voiceband metallic channel interfaces shall assure that:

(i) Ringing voltage is used for alerting only, does not exceed the voltage

and current limits specified in paragraph (d), and is:

(A) Applied to the ring conductor with the tip conductor grounded for 2-wire interfaces, or

(B) Simplexed on the tip and ring conductors with ground simplexed on the tip (1) and ring (1) conductors for 4-wire interfaces.

(ii) Except during the signaling mode or for monitoring voltage, there is no significant positive dc voltage with respect to ground (not over +5 volts):

(A) For 2-wire ports between the tip lead and ground and the ring lead and ground, and

(B) For 4-wire ports between the tip lead and ground, the ring lead and ground, the tip 1 lead and ground, and the ring 1 lead and ground.

(iii) The dc current per lead, under short circuit conditions shall not exceed 140 milliamperes.

(b) *Connection of nonregistered equipment to registered terminal equipment or registered protective circuitry*—(1) *General.* Leads to, or any elements having a conducting path to telephone connections, auxiliary leads or E&M leads shall:

(i) Be reasonably physically separated and restrained from and be neither routed in the same cable as nor use the same connector as leads or metallic paths connecting power connections;

(ii) Be reasonably physically separated and restrained from and be neither routed in the same cable as nor use adjacent pins on the same connector as metallic paths to leads to nonregistered equipment, when specification details provided to the Commission pursuant to §68.200(g) do not show that interface voltages are less than non-hazardous voltage source limits in §68.306(b)(4).

(2) *Connections to registered terminal equipment.* The voltage measurable between auxiliary leads, auxiliary leads to ground, E&M leads and ground, tip and ring, tip to ground, ring to ground, tip 1 and ring 1, tip 1 to ground, and ring 1 to ground shall not exceed 70 volts peak for more than 1 second, with tip to ring, tip 1 to ring 1, and auxiliary lead to auxiliary lead each terminated with 1500 ohms center-tapped through 1000 ohms to ground and each E&M lead terminated in 1500 ohms to ground, if 120 volts rms 60 Hz, ac is applied between all connections to other equipment tied together (except connections to non-hazardous voltage sources) and ground. The source shall not be limited to less than 20 amperes continuously, not to less than 50 amperes for 1 minute, and shall not be interrupted by an overcurrent device permitting less total energy flow than a 20 ampere time delay fuse or breaker.

(3) *Connections to registered protective circuitry.* The voltage measurable between auxiliary leads, auxiliary leads to ground, E&M leads and ground, tip and ring, tip to ground, ring to ground, tip 1 and ring 1, tip 1 to ground, and ring 1 to ground shall not exceed 70 volts peak for more than 1 second, with tip to ring, tip 1 to ring 1 and auxiliary lead to auxiliary lead each terminated with 1500 ohms, center-tapped through 1000 ohms to ground, and each E&M lead terminated in 1500 ohms to ground if either 120 or 300 volts rms to 60 Hz. ac is applied:

(i) Between all protective circuitry connections other than telephone connections (and connection to non-hazardous voltage sources), tied together and ground; and

(ii) Across all protective circuitry connections, other than telephone connections (and connections to non-hazardous voltage sources) which have a transmission path to the telephone connections, with alternative leads grounded; under all reasonable applications of earth ground to the protective circuitry. The source shall not be limited to less than 20 amperes continuously, nor to less than 50 amperes for 1 minute, and shall not be interrupted by an overcurrent device permitting less total energy flow than a 20 ampere time delay fuse or breaker.

(4) *Non-hazardous voltage source.* A voltage source is considered a non-hazardous voltage source if it conforms with the requirements of §§68.302, 68.304, and 68.306(b)(1), with all connections to the source other than primary power connections treated as ''telephone connections,'' and if such source supplies voltages no greater than the following under all modes of operation and of failure:

(i) Ac voltages less than 42.4 volts peak;

(ii) Dc voltages less than 80 volts; and

(iii) Combined ac and dc voltages less than 42.4 volts peak when the absolute value of the dc component is less than 21.2 volts and less than (28.8 + 0.64 × V dc) when the absolute value of the dc component is between 21.2 and 80 volts.

(c) *Hazards from exposed surfaces (to be applied for intentional conductive paths to ground as required by §68.304).* The voltage measurable between auxiliary leads, auxiliary leads to ground, E&M leads and ground, tip and ring, tip and ground, ring and ground, tip 1 and ring 1, tip 1 and ground, ring 1 and ground, shall not exceed 70 volts peak for more than 1 second, with tip to ring, tip 1 and ring 1, and auxiliary lead to auxiliary lead each terminated with 1500 ohms, center-tapped through 1000 ohms to ground, and each E&M lead terminated in 1500 ohms to ground, if 120 volts rms 60 Hz. ac is applied between conductive exposed surfaces and ground. The source shall not be limited to less than 20 amperes continuously, nor to less than 50 amperes for 1 minute, and shall not be interrupted by an overcurrent device permitting less total energy flow than a 20 ampere time delay fuse or breaker.

(d) *Ringing sources.* Ringing sources, except for class A OPS interfaces, shall meet all of the following restrictions:

(1) The ringing signal shall use only frequencies whose fundamental component is equal to or below 70 Hz.[2]

(2) The ringing voltage shall be less than 300 V peak-to-peak and less than 200 V peak-to-ground across a resistive termination of at least 1 megohm.

(3) The ringing voltage shall be interrupted to create quiet intervals of at least one second (continuous) duration each separated by no more than 5 seconds. During the quiet intervals, the voltage to ground shall not exceed the voltage limits given in paragraph (a)(6)(i) of this section.

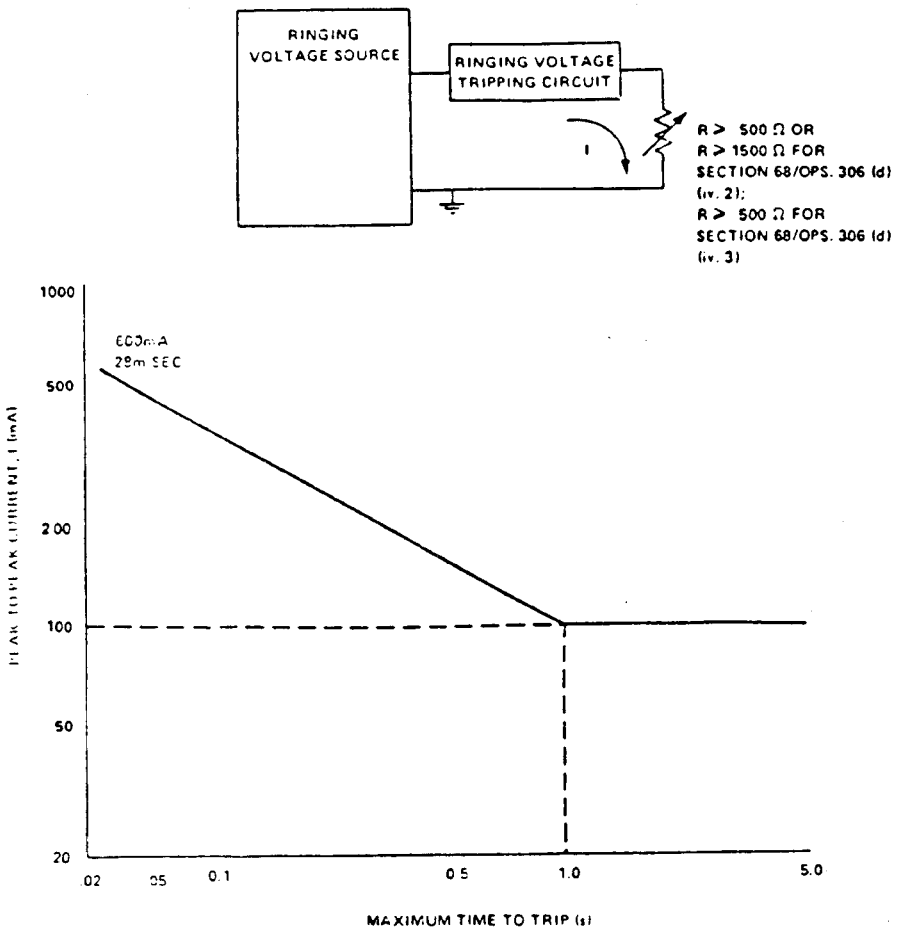
(4) As specified below, ringing sources shall be required to (*a*) include a series current-sensitive tripping device in the ring lead which will trip ringing as specified in Figure 68.306(d), and/or (*b*) provide a voltage to ground (monitoring voltage) on the tip or ring conductor with a magnitude of at least 19 volts peak (but may not exceed the voltage limits given in paragraph (a)(6)(i) of this section) whenever the ringing voltage is not present (idle state). Tripping devices and/or monitoring voltages are required dependent upon the current flow through a specified resistance connected between the ringing source (R(OPS)) and ground as follows:

(i) If the current through a 500 ohms (and greater) resistor does not exceed 100 mA peak-to-peak, neither a tripping device nor a monitoring voltage are required, or

(ii) If the current through a 1500 ohms (and greater) resistor exceeds 100 mA peak-to-peak, the ringing source shall include a tripping device. If the tripping device meets the operating characteristics as specified in Figure 68.306(d) with R=500 ohms (and greater), then no monitoring voltage is required. If, however, the tripping device only meets the given operating characteristics with R=1500 ohms (and greater), then the ringing source must also include a monitoring voltage as described above, or

(iii) If the current through a 500 ohms (and greater) resistor exceeds 100 mA peak-to-peak but does not exceed this value of current with a 1500 ohms (and greater) termination, the ringing source shall include either a tripping device which meets the operating characteristics as specified in Figure 68.306(d) with R=500 ohms (and greater), or a monitoring voltage.

[2] 33 Hz may be the highest frequency necessary for OPS service.



RINGING VOLTAGE TRIP CRITERIA

Fig. 68.306(d)

[45 FR 20854, Mar. 31, 1980, as amended at 45 FR 54342, Aug. 15, 1980; 45 FR 61632, Sept. 17, 1980; 47 FR 39686, Sept. 9, 1982; 51 FR 945, Jan. 9, 1986; 51 FR 16689, May 6, 1986; 60 FR 54814, 54815, Oct. 26, 1995]